Ebola virus disease causes severe hemorrhagic fever, with a case-fatality rate of 50% to 90% (1). The ongoing epidemic in West Africa is the largest Ebola outbreak ever recorded and is rapidly crossing borders. The relentless epidemiologic trajectory and geographic dissemination represent a public health crisis that shows no signs of diminishing under current efforts. We believe that the time to deploy Ebola vaccines is now, as advocated in recent statements by the World Health Organization.

Ebola arises sporadically via zoonosis from fruit bats (the natural reservoir) to humans, often through great apes. Human-to-human transmission occurs primarily through contact with infected body fluids. This transmission route puts health care workers, family members, and persons preparing bodies for traditional funerals at high risk for the disease (1). Although no Ebola vaccines are currently licensed, many candidates have been developed in the past decade. A DNA vaccine has been shown to be safe and immunogenic in a phase 1 clinical trial (2). In addition, a therapeutic vaccine based on recombinant vesicular stomatitis viruses (rVSVs) expressing Ebola virus surface glycoprotein was found to confer prophylactic and postexposure protection in nonhuman primates (3). Despite the promise of these and other Ebola vaccine candidates, none have advanced to late-stage human trials and licensure. The challenge in this process has been the inability to evaluate vaccine efficacy in human populations given the sporadic nature of Ebola outbreaks.

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and quarantine persons exposed to Ebola, are pivotal to controlling spread. Such control methods require trained personnel on the ground in even the most remote locations. Given that nosocomial transmission has contributed substantially to past Ebola outbreaks (1), it is also imperative to integrate vaccination with nosocomial contact precautions and quarantining.

Although vaccine production, transport, and cost are undeniable logistical challenges to any vaccination strategy, the resources required to implement vaccination should be made available by the international community given the magnitude of the threat that the current Ebola outbreak poses to countries in which transmission is occurring and to which it may spread. Even from a pragmatic perspective, it is in the interest of the international community to assist West Africa in containing the Ebola outbreak. Curbilting an outbreak is always easier in its earliest stages than after it has disseminated geographically. That window of opportunity may be rapidly closing.

From Yale School of Public Health and Yale University, New Haven, Connecticut.

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Requests for Single Reprints: Alison P. Galvani, PhD, Center for Infectious Disease Modeling, Yale School of Public Health, PO Box 208034, 60 College Street, New Haven, CT 06520-8034; e-mail, alison.galvani@yale.edu.

Current author addresses and author contributions are available at www.annals.org.

### Table. Viable Ebola Vaccine Candidates

| Mechanism | Properties | Vaccination Scenario | Reference
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<tr>
<td>rVSV + ZEBOV-GP</td>
<td>Trials in NHPs elicited immunogenic response against lethal and aerosol challenge. Conveyed protection in Ebola-exposed and immunocompromised NHPs. Potential for oral administration.</td>
<td>Suited for outbreak response, including postexposure prophylaxis. Also appropriate for use in immunocompromised populations, such as those with a high prevalence of HIV.</td>
<td>3, 7</td>
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<tr>
<td>rRABV + ZEBOV-GP</td>
<td>Trials in NHPs elicited immunogenic response against lethal challenge.</td>
<td>Suited for human and wildlife vaccination. Dual RABV/EBOV vaccine may be more acceptable in endemic areas.</td>
<td>8</td>
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<tr>
<td>DNA + rAd5 + ZEBOV-GP, rAd5 + ZEBOV-GP</td>
<td>Safe and immunogenic in phase 1 clinical trials. Multiple vaccinations may be required. Possible interference with preexisting immunity to Ad5.</td>
<td>Preparedness strategies for health care workers and high-risk populations.</td>
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<tr>
<td>Virus-like particles + ZEBOV-GP + ZEBOV-NP + ZEBOV-VP40</td>
<td>Trials in NHPs elicited immunogenic response against lethal challenge. Virus-like particles can be produced in insect cells, making them suitable for large-scale production.</td>
<td>Preparedness strategies for health care workers and high-risk populations.</td>
<td>9</td>
</tr>
<tr>
<td>rHPIV3 + ZEBOV-GP</td>
<td>Trials in guinea pigs and NHPs elicited immunogenic response against lethal challenge. Potential for needle-free administration.</td>
<td>Preparedness strategies for health care workers and high-risk populations.</td>
<td>10</td>
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<tr>
<td>rCMV + ZEBOV-NP</td>
<td>Trials in mice elicited immunogenic response against lethal challenge. Highly species-specific.</td>
<td>Suited for great ape vaccination in endemic areas.</td>
<td>6</td>
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<tr>
<td>rEBOV subunit vaccine + TLR agonist</td>
<td>Trials in mice elicited immunogenic response against lethal challenge. Subunit vaccines stable for storage and delivery at ambient temperatures.</td>
<td>Suited for stockpiling and vaccine delivery.</td>
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GP = glycoprotein; NHP = nonhuman primate; NP = nucleoprotein; rAd5 = recombinant adenovirus serotype 5; rCMV = recombinant cytomegalovirus; rEBOV = recombinant Ebola virus; rHPIV3 = recombinant human parainfluenza virus type 3; rRABV = recombinant rabies virus; rSVS = recombinant vesicular stomatitis virus; TLR = Toll-like receptor; ZEBOV = Zaire ebolavirus.

### References

Current Author Addresses: Drs. Galvani and Ndeffo-Mbah and Ms. Wenzel: Center for Infectious Disease Modeling, Yale School of Public Health, PO Box 208034, 60 College Street, New Haven, CT 06520-8034.
Dr. Childs: Department of Epidemiology (Microbial Diseases), Yale School of Public Health, PO Box 208034, 60 College Street, New Haven, CT 06520-8034.

Author Contributions: Conception and design: A.P. Galvani, J.E. Childs.
Analysis and interpretation of the data: J.E. Childs.
Drafting of the article: A.P. Galvani, M.L. Ndeffo-Mbah, N. Wenzel.
Critical revision of the article for important intellectual content: A.P. Galvani, J.E. Childs.
Final approval of the article: A.P. Galvani, M.L. Ndeffo-Mbah, N. Wenzel, J.E. Childs.
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